International Journal of Disaster Risk Reduction 31 (2018) 1266–1275

Contents lists available at ScienceDirect

International Journal of Disaster Risk Reduction

journal homepage: www.elsevier.com/locate/ijdrr

Adaptation by the least vulnerable: Managing climate and disaster risks in Finland

Karoliina Pilli-Sihvola[a,b,*], Atte Harjanne[a,c], Riina Haavisto[a]

[a] Finnish Meteorological Institute, P.O. Box 503, FI-00101 Helsinki, Finland
[b] University of Helsinki, Faculty of Agriculture and Forestry, Helsinki, Finland
[c] Aalto University School of Business, P.O. Box 21210, FI-00076 Aalto, Finland

ARTICLE INFO

Keywords:
Adaptation
Climate change
Disaster risk reduction
Finland
Governance
Welfare state

ABSTRACT

Disaster risk reduction (DRR) and climate change adaptation (CCA) literature has traditionally focused on the countries and regions hit hardest by natural hazards. In this paper, we take a different perspective by turning our eyes upon Finland, a Nordic welfare state and a low vulnerability and exposure society. We analyse and discuss how well the existing DRR and CCA approaches reflect the perspective of the least vulnerable countries and whether the current ways of determining vulnerability and exposure neglect some risks or hinder the seizing opportunities brought by climate change.

This paper is based on data gathered in a survey, interviews and workshops in two research projects which analysed weather and climate related risks in Finland. We conclude that disaster risk assessments need to be contingent and account for social and economic contexts. In an institutionally well-functioning welfare society, vulnerability assessments should emphasize relative changes in perceived social trends and social cohesion. Exposure should not be limited to direct geographical or physical exposure to local natural hazards. Successful opportunity identification can help improve DRR at home and abroad. In general, the role of political systems and culture as enabling factors for DRR and CCA need further study.

1. Introduction

"*An ounce of prevention is worth a pound of cure.*"

The words attributed to Benjamin Franklin are as relevant today as they were in the 18th century; the complex and interlinked risk landscape that the modern world faces requires holistic, comprehensive approaches to reduce and manage these risks. Disaster risk related to weather and climate is one of the many risks faced by communities, societies and states. The climate is changing, exposing people to its impacts across the globe [37]. To make matters worse, this development takes place in a world which has by no means dealt with the natural hazards and disasters of the current climate (see e.g. [10]). As indicated by Franklin, and shown in many, although not in all cases, there is even economic rationale to act prior to the occurrence of major impacts [4,76]. This requires effective and efficient governance; i.e. policies and measures, and in many cases, transformative changes in societies to reduce the impacts of natural hazards and the changing climate.

Traditionally, the literature on disaster risk reduction (DRR) and climate change adaptation (CCA) has focused on the places hit hardest by weather and climate. This is no surprise, as it is only natural that the most relevant context for studying DRR or CCA are those where natural forces create disasters or where CCA challenges have already arisen. For example, in the articles published in the International Journal of Disaster Risk Reduction, the ten most frequently analysed countries comprise over half of all the country specific studies[1]; and none of the countries are European. Furthermore, in many studies, focus is placed on local or regional cases, and the role of national, state level governance is excluded or overlooked.

How, then, do DRR and CCA look from the perspective of a country that has not suffered any large-scale disasters triggered by natural hazards in the recent past, yet is constantly adapting to its challenging weather and climate conditions? What does adaptation entail when undertaken by the 'least vulnerable'? In this paper, we present an exploratory case on DRR and CCA in Finland; an EU Member State that is

* Corresponding author at: Finnish Meteorological Institute, P.O. Box 503, FI-00101 Helsinki, Finland.
E-mail address: karoliina.pilli-sihvola@fmi.fi (K. Pilli-Sihvola).

[1] We assessed all the articles on IJDRR Volumes 1–21 (for 21 up to 21 December 2016 as it was still in Progress) and identified 379 country mentions in titles or abstracts. 212 were about the top ten of India, United States, New Zealand, Bangladesh, Australia, Japan, Pakistan, Indonesia, China, Thailand and the Philippines.

https://doi.org/10.1016/j.ijdrr.2017.12.004
Received 12 March 2017; Received in revised form 8 December 2017; Accepted 10 December 2017
Available online 15 December 2017
2212-4209/ © 2017 Elsevier Ltd. All rights reserved.

wealthy and stable[2]; has well-functioning governance structures; has a small population of 5.5 million people [79]; exhibits strong Nordic welfare state structures [20,59]; is not located in a hazard-prone area; and has a comprehensive approach to societal security. Finland can be seen as an example of a country where post-World War II development has also been a story of successful adaptation to climatic extremes and, so far, to climate change. This is confirmed by international indicator-based country comparisons on vulnerabilities. Samson et al. [73], Standard & Poor's [78] and Notre Dame Global Adaptation Initiative [56] all rank Finland among the countries least vulnerable to climate change.

Even though Finland does not face major natural hazards, such as cyclones or major flooding, the country has not always been immune to disasters triggered by weather and climate. In 1866–1868, an estimated 8% of the Finnish population perished in a famine triggered partially by adverse weather [92]. Strict public regulation, societal progress and major investments in ensuring that all vital societal functions work in exceptional situations have resulted in a country where natural hazards do not turn into disasters, and where climate change may actually bring beneficial opportunities if successfully harnessed [60].

The aim of the paper is two-fold:

1) to describe the Finnish model and the role of governance and society for DRR and CCA; and
2) to analyse and problematize the existing frameworks that guide—or are designed to guide—the theoretical and practical fields of DRR related natural hazards and CCA through the findings from the case description.

This paper is not the first to analyse the role of societal structures and governance in DRR and CCA. For instance, Alexander and Davis [2] suggest five factors that constitute as 'the elephant in the room' in DRR publications and gatherings: the human right to hazard information; explosive population growth, corruption, how people are placed at risk by the actions of governments; and gender discrimination. This is complemented in the *Global Assessment Report on Disaster Risk Reduction 2015* ([86], p.254) as follows: "The governance of disaster risk is never autonomous from the quality of governance in general. Strengthening the quality of overall governance is therefore critical to strengthening the governance of disaster risk". However; Nordic countries, where the level of societal progress is high and rather equal among citizens, and the relative disaster impacts are low, are often forgotten in the literature. Alexander and Davis [2] discuss the importance of governance for donors and international agencies in development context, and UNISDR [86] focuses on countries with major disaster losses. Adaptation deficit [9] describes the lack of adaptation capacity that many low-income countries face in front of climate change due to political, institutional and technological reasons (e.g. [8,18,23])

We argue that there is value in bringing a new perspective in the discussion by analysing DRR and CCA in Finland for two reasons: First, the current literature covers a seemingly narrow geographical scope. Second, analysing DRR and CCA from a fresh perspective, by presenting a success story, can reveal novel thoughts on DRR and CCA and help to further improve the concepts. The implications of the Nordic structures to the disaster risk management and resilience are also explored in Pursiainen [65] and van Well et al. [89] in this issue.

The role of national level—and in the European Union (EU) supranational level—governance is crucial in DRR and CCA. Over the past decades in Europe, disasters and climate change have been politically addressed through various policy initiatives and extensively studied in EU-funded research programmes. The Union Civil Protection Mechanism (UCPM) from 2013 [14], The Floods directive [15] and the EU CCA strategy from 2013 [13] are all EU-level policies which aim at improving Member States' prevention and preparedness for extreme hydro-meteorological events and climate change. For instance, the UCPM requires all Member States to undertake national risk assessments every three years; the Floods directive requires the creation of flood hazard and risk maps; and the CCA strategy encourages all Member States to develop national CCA strategies, which has been accomplished by nearly all member states by 2017 [16].

Thorough research and strategy work on CCA has, however, also been pointed out as a potential source for complacency. Indeed, even if CCA strategies are in place and sectoral impacts are known, it does not guarantee that they result in effective adaptive policies or actions [57]. Integration of CCA into other policies and practices—so called mainstreaming—is considered a necessary enabler for effective adaptation to climate change [17]. Biesroek et al. [6] argue that institutional challenges can hinder CCA in Europe and more recently, Eisenack et al. [17] argue that such barriers are still retarding CCA efforts.

Despite mostly overlapping goals and measures, DRR and CCA are for the most part two distinct governance and research fields [63,7,77,84]. This is also the case in Finland, and therefore, we consider it both justified and useful to review DRR and CCA hand in hand but as distinct policy and governance processes. Section 2 describes our research design and methods and Section 3 describes the case study context; the social and physical characteristics and our findings about the DRR and CCA processes. In Section 4 we discuss the implications of the case to the frameworks used within DRR and CCA. Section 5 provides concluding remarks.

2. Research design

2.1. Key frameworks and concepts

Two parallel, yet partly overlapping risk frameworks are typically used in the disaster and climate literature to explain the weather and climate risks faced by communities and societies.

The Intergovernmental Panel on Climate Change [36,37] conceptualizes disaster risk as determined by *vulnerability*, *exposure* and *weather and climate events, or more broadly natural hazards*. Vulnerability refers to the propensity to be adversely affected by the hazards, exposure is the presence of people, livelihoods, resources, environmental services or any other assets of value in places that can be affected, and weather and climate events or natural hazards are the physical phenomena that can be potentially dangerous or harmful.

A more comprehensive model to understand weather and climate risk is the so-called Pressure-and-Release (PAR) model described in Wisner et al. [94]; which, similarly to the framework in IPCC [37,36], presents vulnerability as a component in disaster risk, yet describes vulnerability as consisting of three parts: root causes, dynamic pressures and unsafe conditions. Wisner et al. [94] focus on least developed countries in their examples of PAR as a practical analytical tool; however, Rauken and Kelman [68] use the model to analyse the root causes behind river flood risk in Norway. They find that the political system; distribution of power and responsibilities, and the economic system with a focus on economic growth without addressing the flood risk are the root causes behind river flood risk.

As noted by e.g. [1, p. 21], the concept of vulnerability "cannot be separated from the social and cultural conditions under which it exists"; any indicators of vulnerability, and thus risks need to be contingent and take into account the social and economic context of the unit of analysis. One very particular context to study risks and vulnerabilities is the welfare state system, which, according to Esping-Andersen [19] historically has aimed at equal opportunities to individuals and eliminating social risks across the life cycle.

According to the traditional categorization by Esping-Andersen [20], the Nordic welfare state model is based on a social democratic ideology and built around the central role of state in providing security and welfare such as social, educational and health services. Social

[2] http://fundforpeace.org/fsi/ [Accessed 8.12.2017].

benefits are available to all members of society and the main mechanism supporting social security and ensuring equality is progressive income transfer. Particular examples of equal welfare services are uniform child and childcare benefits for all and free primary to tertiary education.

2.2. Methods

The research approach used in this study is explorative (see [83], 5–9); instead of constructing an empirical study with robust evidence, we aim to contribute to the literature by constructing a fresh viewpoint and discussing its implications. By presenting and analysing the case of Finland adapting to climate change and reducing disaster risk, we aim to bring about interesting observations of DRR and CCA processes and frameworks in general. Two research questions guided our work: 1) How well do the existing DRR and CCA approaches reflect the perspectives of the least vulnerable and exposed countries? 2) Do the current ways of determining vulnerability and exposure undermine some climate or disaster risks or hinder the seizing of opportunities brought about by climate change?

The case study is built on data gathered in two research projects, one Nordic and one Finnish. The collaborative Nordic research project undertaken within NORDRESS Centre of Excellence on Resilience and Societal Security[3] analysed the institutional foundations of natural hazard management within Nordic countries (for more detailed description, see [32]). This study gathered views of experts working with DRR and CCA through an online survey (47 responses), semi-structured interviews (8 interviewees) and a two-day expert workshop (15 participants). In addition, a broad desk study was conducted in which grey literature, legislation and official guiding documents defining DRR and CCA processes within the Nordic countries were reviewed. The final outcome of the study was a comparative analysis of the similarities and differences within these processes and related institutions in Denmark, Finland, Iceland, Norway and Sweden. The data was collected in 2015 and 2016.

The Finnish project analysed various aspects of weather and climate risks in Finland under the Government's analysis, assessment and research activities (see [30]). The ELASTINEN[4] project was structured around multiple parallel analyses, and data were collected using various methods. For this paper, the most relevant data was collected in an online survey, seven interviews and a workshop. The online survey covered perceived weather and climate risks, use of weather and climate information and improving preparedness. The survey was aimed at Finnish organizations in general and received 118 responses. Analysis of the responses for a similar survey targeted at municipalities is reported in Räsänen et al. [67]. The workshop was held in January 2016, had 42 representatives of different private and public stakeholder organizations and consisted of interactive sessions that aimed to validate and complement the results of the online surveys and collect views on how to improve climate risk management tools and information services in Finland. The interviews were held with experts working on flood risk management and CCA in Helsinki, the capital of Finland.

In addition to the observations and conclusions made in these projects, the case description and analysis was complemented by available literature and statistical data. All three authors have also been involved in various DRR and CCA research projects, consultations and interaction events in Finland, and use their personal experiences in forming a consistent case description out of fragmented and diffuse data available. In our case study writing, we include references when presenting exact claims or relevant conclusions from earlier literature; otherwise the claims are based on our interpretation of the data and observations collected within the two projects.

While some of the conclusions are based on quantitative data, our study is mostly based on qualitative research. It follows loosely the so called “Gioia Method” [29,49] in choosing a single case for its revelatory potential and aiming for conceptual contribution instead of theory development. As a case study, it is exploratory and intrinsic in nature but with some descriptive elements (see [5]). The intent is not to achieve generalizations beyond the limited frame of Nordic welfare states or to evaluate specific policies nor to validate premeditated hypotheses. Instead, we aim at constructing a revealing and interesting case that provokes new ideas and discussion on how DRR and CCA can and should be approached.

3. Finland - a country without weather and climate risk?

3.1. Disaster risk

Finland is located in North-Eastern Europe. Together with Denmark, Sweden, Iceland and Norway, it is one of the Nordic countries. The climate is challenging for primary production and logistics, and without modern technology and good governance, food production would most likely be disaster-prone. The worst famine in Finland's history occurred approximately 150 years ago, and resulted in the death of estimated 8% of the population and was the result of long-term societal, economic and political factors, which were exacerbated by rainy summers and frost in September 1867 [92]. However, considering the vulnerability, hazard and exposure aspects, one could summarize that nowadays, because of the welfare state characteristics with high social cohesion, trust, equality, relative wealth, and mild natural hazard levels compared to other countries, Finland is a country with low weather and climate risk.

The damages from natural hazards that have occurred in recent years demonstrate the country's relatively low weather and climate risk level. As an example, cyclone Gudrun which hit Denmark, Sweden and Estonia in January 2005 resulted in 75 million m^3 of fallen forest in southern Sweden,[5] whereas the largest recorded forest damage in Finland has been approximately 8.1 million m^3 in 2010, caused by four consecutive extra-tropical cyclones in the summer 2010. Between 2011 and 2015 in Copenhagen, Denmark, major urban downpours have caused total economic damage worth approximately 1.2 billion euros [12], whereas the flood caused by heavy rains in the city of Pori in 2007 damaged buildings and infrastructure, and resulted in estimated costs of 22 million € [11].

3.2. Climate

In global comparison, natural hazards are rather modest, and none of the geophysical characteristics can be described as extreme. The earthquakes are rarely above 2 in magnitude [35]. Finland lies far from volcanic hot spots and the edges of the Eurasian tectonic plate: there are no volcanoes and the miniscule earthquakes can only be detected using sophisticated technical equipment. Slopes are low and gradual and thus limit gravitational flows, although avalanches are not completely unheard of in the low mountains in Lapland [74]. The climate is a mix of continental and maritime climate and in general more continental compared to the rest of the Nordic countries [25,26]. It can be characterised by high variability in seasonal climatological cycles and high climate variability [64]. More specifically, five climate zones are identified following the Köppen climate classification (the impact of temperature and precipitation on vegetation): hemi-boreal, south-boreal, middle boreal, north-boreal and subarctic [26]. Storms are most frequent in late autumn and winter when they are driven by major

[3] NORDRESS (Nordic Centre of Excellence On Resilience and Societal Security) http://nordress.hi.is/ [Accessed 8.12.2017].

[4] ELASTINEN (Proactive management of weather and climate related risks) http://en.ilmatieteenlaitos.fi//elastinen [Accessed 8.12.2017].

[5] http://www.smhi.se/kunskapsbanken/meteorologi/gudrun-januaristormen-2005-1.5300 [Accessed 8.12.2017].

depressions, but they can take place throughout the year [40]. Storm winds also occur during convective thunderstorms mostly in summer months. The absolute wind speeds in these storms are again modest in international comparison. There are, for instance, no known instances of hurricane level wind speeds over 33 m/s at least as long as modern observations have been made [28].

The discharge of the free running rivers is small in comparison to for instance the big rivers in central Europe and while they can cause fluvial flooding, the severity of these events is low on an international scale. Yet floods do happen, and the seasonal discharge patterns are projected to change in the future, which will also affect flooding [90].

Finland has already witnessed warming in its climate during the last 150 years [51], and the future warming is expected to be significantly higher than the global average [51,70]. In general, the climate will get wetter and hotter. Winter months warm the most, and winters become moister, cloudier and less snowy [69]. Sea level rise on the coast is partially compensated by the residual land mass uplifting still following the loss of ice cover from the last ice age. Yet, the projections show that sea level will rise by the end of the century by 29 cm in the Gulf of Finland, while in the Bothnian Sea and Bothnian Bay the change is − 5 cm and − 27 cm, respectively, due to the landmass uplift [38].

3.3. Governance of weather and climate risks

Finland has been an active participant in the international co-operation within the United Nations International Strategy for Disaster Reduction (UNISDR). Finland had a high profile in the development of the Hyogo Framework for Action [88]. Domestically, Sendai [87] and Hyogo frameworks have resulted in co-operation networks between authorities and Finland has prepared extensive reports on its DRR actions [32]. In 2016, the 7th annual meeting of the European Forum for Disaster Risk Reduction in was organised in Helsinki as Finland was the European regional chair. Three important outcomes, which were also mentioned by Finland at the Global Platform on Disaster Risk Reduction held in Cancun 24–26 May 25, 2017 were:

> *"First, we need a stronger engagement by political leaders and decision makers in moving forward the DRR agenda and Sendai Framework implementation. Second, we need strengthened coherence and mutually reinforcing implementation between the Sendai Framework and other recent international agreements and processes, including the 2030 Agenda for Sustainable Development, the Paris Agreement on climate change and the New Urban Agenda - not only in theory but also in practice. Third, we need reliable reporting mechanism based on agreed terminology and indicators".*

Yet, the national governance structures are more complex than implied by the statements in international fora. DRR and CCA governance follows the internationally witnessed separation of the DRR and CCA fields, as shown in Fig. 1. The Ministry of the Interior, responsible for civil security and safety, has a coordinating, rather than commanding, role in emergency situations and it acts as the national focal point for DRR. The Ministry of Agriculture and Forestry is responsible for CCA coordination.

The main DRR governance principles are self-sufficiency, which refers to the idea that the responsibilities and roles of authorities, organizations and individuals are the same in both normal and exceptional conditions (i.e. there is no national civil protection agency that would take control in disaster situations); and locality, which complements the idea of self-sufficiency (i.e., disasters are managed on the lowest possible level and only if escalated). The National Risk Assessment 2015 [55] assesses six events that have a major impact on society and 15 events that have serious regional impacts. Nine of these events are directly or indirectly related to weather and climate:

- serious disturbances in electricity distribution due to e.g. storms,
- information security risks due to e.g. storms or floods,
- solar storms,
- rapid flooding in or near the population centre,
- large marine accidents due to e.g. harsh winter navigation conditions,
- multiple simultaneous extensive forest fires,
- extensive or long-lasting disturbance of water distribution due to e.g. storm,
- winter storms including long frosty periods,
- thunderstorms.

From a holistic risk reduction perspective, threatening weather and climate risks are included in the Security Strategy for Society [75], given as a Government Resolution and coordinated by the Security Committee. The Security Strategy describes the roles of different national entities in the face of disasters, and is based on a holistic cross-sectorial viewpoint, emphasizing vertical and horizontal responsibilities. Together these principles mean that DRR is quite polycentric and the responsibilities are distributed to various authorities on different jurisdictional levels. All ministries, and the Prime Minister's Office, the National Emergency Supply Agency,[6] six Regional State Administrative Agencies, 22 rescue departments, the 317 municipalities, as well as several national agencies and institutes, and the civil society have important regional or national roles in DRR during normal and exceptional circumstances.

This arrangement was described as a “mess” in one of our workshops. However, the complex and decentralized organization of DRR has been compensated by co-operative and coordinating measures. As a result, there is little overlap in responsibilities or capacities of different authorities, although the chains of command and operative procedures can turn out to be complex during an exceptional event. Finnish authorities also a have long tradition of co-operation between different sectors as well as the private sector, that stems from cold-war era civil defence preparedness. This idea of total defence, based on the concept of comprehensive security, is unique in international comparisons [34] and has provided continuity in national preparedness policies despite of the collapse of the Soviet Union [48,65].

The ‘messiness’ is not reflected in the survey on the management of global risks conducted by the World Economic Forum for their 2013 Risk Report ([93, p. 66]), where 36 ‘top managers’ from Finland were asked to assess their “national government's overall risk management effectiveness of monitoring, preparing for, responding to and mitigating against major global risks”. In the survey, Finland ranked 9th out of 139 countries surveyed, indicating that the government is considered to be well capable of managing the risks faced by Finland.

The Ministry of Agriculture and Forestry has ensured that, if measured by national level strategy work, Finland can be considered a CCA pioneer [40]; as witnessed by the first national adaptation strategy in Europe in 2005 [54]. Finland and Denmark are forerunners in Nordic CCA, in that they both have explicit requirements for CCA in their land use planning legislation, whereas the other three Nordic countries do not [32].

The revised *National plan for Climate Change Adaptation 2022* was set in 2014 as a governmental order [53], and sets three overarching goals: a) mainstreaming adaptation, b) providing necessary climate risk assessment and management tools, and c) improving adaptive capacity, creating innovative solutions and increasing public awareness with research and development, communication and education. These goals are pursued by 14 actions, each of which consists of a set of more detailed actions with assigned responsibilities and resources [53]. Although opportunities are brought up, alongside risks and indirect impacts, the general tone of the strategy is quite conventional. It describes a general process of climate risk management where changes and risks are identified, the risks are assessed according to their likelihood and

[6] https://www.nesa.fi/ [Accessed 8.12.2017].

Fig. 1. CCA and DRR governance levels and examples of governing bodies and guiding frameworks in Finland.

impact, and solutions are developed accordingly.

Two challenges regarding effective CCA implementation have been identified. Finland, among other Nordic countries, has been a forerunner in CCA research [46]. However, Klein and Juhola [46] point out that there has been a gap between research and putting policies into practice. This gap results from the distance between the theoretical concepts and the reality of decision-making, uncertainty of information, scale mismatch between climate information and actions, prioritization of current variability and short-term decisions; in contrast to the medium- to long-term perspective of adaptation research, and forgetting the fact that CCA is only one of many stakeholder concerns and seldom the most salient [46]. This challenge was confirmed by the observations from our projects as well.

Another challenge stems from bridging national and regional and local adaptation actions [42]. National high-level strategies have had limited impact on the regional and municipal levels where the lack of skills and resources hinder the implementation of actions. Juhola et al. [42] describe how regional climate work is almost completely project-based and relies on external funding. The same point was made in a workshop held in the ELASTINEN project. Stakeholders from both public and private organizations expressed their frustration on endless stream of projects and hoped to see continuous work toward holistic CCA. Thus, without resourcing or new arrangements of responsibilities, the goal of CCA mainstreaming is difficult to achieve.

The integration of DRR and CCA is currently taking place at research level, as the national weather and climate risk assessment commissioned by the Prime Minister's Office considers extreme weather events and longer-term changes in the Finnish climate. Integrating DRR and CCA into other global policy contexts, such as the Sustainable Development Goals, however, remains to be seen.

3.4. The Nordic welfare model and vulnerability reduction

From vulnerability perspective, Finland is well prepared to face the impacts of extreme weather events and climate change. The GDP per capita was approximately 39,000 euros in 2016 [80], ranking 8th within the European Union [22] and Finland is, for instance, the 8th best performing country according to the Better Life Index of the Organization for Economic Co-operation and Development.[7] The economy relies mostly on services: 70.2% of value added as proportion of gross value added comes from services, 27.1% from secondary production and 2.7% from primary production (preliminary statistics for 2016) [80]. Due to its broad social security and public services, Finland can be considered a welfare state, and more specifically a Nordic or Scandinavian welfare state [66].

The Nordic welfare state expresses itself in various ways within the economy and society. Equality in income distribution, high institutional trust and high level of education are all general characteristics of Nordic welfare states. The income distribution is in global comparison quite flat; the most recent Gini coefficient was 0.257, 5th lowest in the OECD countries.[8] Finns have in general high levels of trust for each other, the political and legal systems and the authorities; levels of trust to all of these are high in international comparison, and in some of them Finland ranks on top [47]. Finland is a top scorer in the yearly Corruption Perceptions Index by Transparency International; in 2015 it was the third least corrupt country in the world after Denmark and New Zealand.[9] Finns are also quite highly educated, with 71% of population over 15 years of age holding a degree beyond primary schooling [81]. The population is fairly homogeneous as only 4% of inhabitants are foreigners and 90% of the population speak Finnish as their native language and almost 86% of the population live in cities or towns [82] Urbanization is progressing further quite rapidly. According to the Gender Inequality Index measured as part of the Human Development Index of the United Nations Development Programme, in 2015 Finland ranked 8th most gender equal country in the world [85]

The public has a high trust in the ability of the society to recover from disasters, and Finns are willing to help each other and provide volunteer aid in disasters. Households consider themselves well prepared for disasters or contingencies in general, but there is a significant difference in preparedness between rural and urban populations; the former are better prepared [50].

3.5. Examples of implementation

Not only is the entire welfare state structure and the dispersed governance system based on the idea of ‘comprehensive security’, but specific, integrated DRR and CCA measures have been designed and implemented since 2000.

A good example of a highly effective, although not necessarily economically efficient, DRR and CCA integration is the amended Electricity Market Act 2013 [71]. The Act was partly a response to the long, regional power outages caused by winter and summer storms, and is a good example of a national level response to regional challenges. The Act poses strict requirements on the length of electricity blackouts;

[7] http://www.oecdbetterlifeindex.org/#/11111111111 [Accessed 8.12.2017].

[8] http://www.oecd.org/social/income-distribution-database.htm [Accessed 8.12.2017].

[9] http://www.transparency.org/cpi [Accessed 8.12.2017].

in rural areas (excluding premises without permanent residents), blackouts shall not last over 36 h, and in urban areas, blackouts shall not last over 6 h. If these thresholds are not met, the electricity distribution companies have to pay heavy compensation to their customers. The transition period lasts until 2029, and mid-term goals have to be reached by 2019 and 2023. This has led to a situation where many electricity distribution companies are required to improve the reliability of their networks, mainly through converting traditional air-cable lines into underground cables. However, a cost-benefit analysis of the enactment of the Act shows that the electricity companies enforced the law by the installation of ground cables and the economic feasibility of the law enactment varies according to the discount rate. With a 3% discount rate the benefits are greater than the costs, whereas with 5% discount rate the benefits are smaller than the costs. This highlights the fact that in the Finnish context, where disaster risk is in many ways under control, large investments in DRR and CCA are not necessarily economically efficient. [61]

An example of a well-functioning multi-sectoral, integrated DRR and CCA activity is the early warning service LUOVA [27]. Launched in 2012, it is used to distribute natural hazard and early warning information to the highest government officials and all security authorities. In addition, more limited announcements are available for a broader range of subscribers. LUOVA is maintained by the Finnish Meteorological Institute while warnings are also prepared by the Finnish Environment Institute and the Seismologic Institute within the University of Helsinki. The hazards are monitored both in Finland and abroad to be able to safeguard Finns and the interests of Finland globally. LUOVA is an operational early warning system to enable efficient preparedness and response in the face of an emergency situation. Therefore, it does not directly include climate change information or scenarios. However, early warning systems are an efficient way of reducing also the impacts of climate change in the face of projected changes in extreme weather events and, for instance, related to changing winter driving conditions [62]. Another similar DRR and CCA measure is the Flood Centre, jointly operated by the Finnish Meteorological Institute and the Finnish Environment Institute. The purpose of the Flood Centre is to forecast and warn of impending flooding situations to authorities, and residents and businesses in flood-prone areas.

The prioritization of CCA actions seems, however, to be one of the key challenges both in private and public Finnish organizations. Spatial planning is perhaps the activity where CCA mainstreaming has been developed the furthest; as there are clear regulations or at least non-binding guidance on managing flood risk, including storm water and sea level rise [91]. In largest cities, resources are not an issue as there is expertise to properly design adaptation. Still, other priorities such as housing targets or other economic drivers result in changes that hinder the planned adaptation when spatial plans are implemented or when areas are maintained.

3.6. Risk perception

The relatively low risk-level is also reflected in the risk perceptions. While flooding and storms are considered potentially harmful by households [50], the likelihood of problems created by extreme weather and climate events is considered low [44]. In the ELASTINEN-study, organizations considered weather and climate risks on average as relatively small—but not insignificant—compared to all risks in general [31]. Furthermore, the study found that heavy rains, flooding and storms were the main hydro-meteorological concerns of the respondent organizations that included both public and private sector entities across the country. When looking to the future, organizations considered extreme events as a more significant threat than gradual changes in climate. The idea that climate change is not a direct threat to society seems to be reflected in risk perceptions too. Finns are among the least worried Europeans when it comes to climate change [21] and in the organizational survey, a majority of the ELASTINEN-study respondents considered climate change to create positive impacts or benefits, such as new business opportunities or improvement in relative competitiveness [31].

Despite of, or perhaps due to, the challenging climate that the businesses operate in, low priority of CCA shows as low awareness. While awareness of climate change mitigation and the importance of corporate social responsibility may be on the rise, CCA actions, beyond fulfilling scattered regulations, have been rare among Finnish enterprises. Furthermore, low demand for CCA related climate information or services has been witnessed. From business perspective, CCA does not stand out as a distinct activity but has instead merged within other risk management processes. According to the results of the ELASTINEN survey [31], the lines between climate change adaptation and mitigation are also blurred in Finnish businesses, as globally suggested by Okereke et al. [58].

The general consensus is that the expected climatic changes may actually result in direct benefits to the economy. In agriculture, the growing season becomes longer [60], the increased warmth and CO_2 accelerates forest growth [45] and the need for space heating decreases [43] It is not surprising that the wish for a more pleasant European climate is a recurring joke in Finnish events or meetings focusing on climate change. Yet things are not that straightforward. Less ice and snow on the road can mean less accidents, but if these conditions come even more as a surprise the risk of accidents may increase [72]. Moreover, the costs of maintaining the road infrastructure will probably increase due to climate change [24]. Naturally, there are also concerns of directly adverse impacts of climate change.

4. Discussion

4.1. The Finnish model – success story with looming unrecognised risks?

What can we then learn from the Finnish perspective on CCA and DRR? The established IPCC framework that defines natural hazards, vulnerability and exposure as the determinants of climate or disaster risk does not reflect the Finnish situation very well. Objectively assessed, all these factors and thus risks are low, and in international comparison they are even lower. The physical reality is reflected in organizational and individual perceptions; Finns do not feel threatened by weather or changing climate.

Still, as described, Finnish climate can be challenging, and Finns are for example able to manage snow and temperature conditions (e.g. temperatures down to − 45° to − 50° centigrade in northern Finland) that could be nearly disastrous in other societies. This DRR and CCA has not, however, resulted from modern DRR and CCA policies but is more a result of learning from experience, good governance and improved adaptive capacity due to rising living standards and better technology, which has been put to use with resolve. Yet, it is difficult to evaluate whether Finland is well prepared and able to adapt to future challenges. This is especially true for climate change which has the potential to cause indirect risks, countering the potential local benefits of climate change. As pointed out in O'Brien et al. [57]; Johannessen and Hahn [38]; and Klein and Juhola [46], when climate risks are perceived to be low, the resulting complacency might lead to inaction in adaptation despite the theoretically high adaptive capacity. Based on our observations, this may be a very conceivable risk for Finland.

While it may be that the direct climate change impacts are not severe compared to other countries, there are indirect mechanisms that can cause harm and damage (see an overview for Europe in [16]). Finland is economically, politically, socially and biophysically connected to the rest of the world, and changes abroad will have ripple effects here as well [33]. Naturally, the indirect impacts within a global economy are likely to be mostly negative and can in some cases be more severe than the direct ones [33]. Also, seizing the potential opportunities requires active CCA. Broader environmental sustainability issues, such as increased eutrophication due to increased agriculture, may also

become an issue. Furthermore, the joint occurrence of natural hazards and purely man-made risks (such as cybercrime etc.) may be an event which is hard to assess from probabilistic perspective, but may well pose a serious threat to the functioning of society.

The Finnish case enhances the notion that natural hazard, exposure and vulnerability are highly context-dependant. In a welfare state with low levels of absolute risks, a very straightforward interpretation of the key DRR and CCA concepts can lead to policy work that does not guide or connect to actions in practice. DRR and CCA frameworks can be thought of as a spectrum, where very different situations between countries should be reflected in risk assessments. There are countries where the most threatening hazards are self-evident, exposure has clear geographic and physical definitions and where economic welfare can be used directly as a proxy for vulnerability. Finland as a Nordic welfare state with low levels of natural hazards and exposure is not such a country.

How do DRR and CCA then come together in Finland as a whole? A fitting phrase to describe Finnish approach is “by the book”. Strategies and policies are in place and they are developed according to up-to-date views within the fields, emphasizing co-operation and integration of DRR and CCA with each other and into other policy fields, broad definitions of risk and focusing on prevention over damage control. In parallel to this high-level strategy work, everyday operations linked to DRR and CCA such as spatial planning, construction work and emergency services are run and developed according to their short-term learning cycles. Based on our observations, these two levels are—while not completely separated—not always very closely interacting. It is possible that society is highly adapted to current climatic variations and disaster possibilities, but qualitative changes and new types of risks might catch Finns by surprise, even if these risks could in principle be anticipated.

This gap makes evaluating the effectiveness of Finnish DRR and CCA difficult. Another complicating factor is the fact that there are no frequent disasters or significant adverse climate change impacts. In this sense, the Finnish DRR and CCA have not yet been put in a test, so it cannot be stated whether they are in line with the risks or not. What is lacking from the strategies though, is clear prioritization. The scale of impact of different risks is however likely to vary significantly.

Does the case of Finland provide any lessons learnt for countries where hazard and governance profiles are substantially different? The transferability of the Nordic social welfare model is beyond the scope of this paper, as the process of transferring institutional structures between states is complex and contingent in itself (see e.g. [69]); and there has also been debate about the viability of the Nordic welfare model in an increasingly globalised economies [3]. However, the governance structures, social cohesion, well-functioning institutions and relatively equal society are a direct reflection on the factors of the ‘elephant in the room’ by Alexander and Davis [2] and the UNISDR [85]. In this paper, we show that by addressing these issues at governance level provide major benefits in reducing weather and climate related disasters prior to their occurrence.

4.2. Broadening the key concepts

Following the example of Finland, the key weather and climate risk concepts; hazard, exposure and vulnerability, could be adjusted as follows:

For **vulnerability**, relative changes in perceived social trends and social cohesion should be emphasized. As we’ve seen we’ve the rise of extremist and populist movements in Europe and the United States, even a developed, growing and stable economy can start imploding if large parts of society feel threatened or disempowered by future societal development. It does not necessarily matter whether or not the perceived risks are real in any meaningful scale, as long as they are perceived to matter. Such implosion may then threaten governance structures and legitimacy and indirectly but significantly affect DRR and CCA capacities.

Socio-economic vulnerability reduction should be key in reducing people's and societies’ capacity to reduce and cope with extreme weather events and climate change. The social welfare system, present in the Nordic countries, can be considered as holistic vulnerability reduction in the sense that it provides people with the economic means to cope with many of the risks that are present in modern life, not only weather and climate related risks. This increases people's capacity to function in exceptional situations and disturbances, regardless of their origin. People have the economic means to live in resilient buildings, and even in the case of loss of livelihood, the state takes care of one's, and one's family's, basic needs. This can be complemented with a holistic approach to infrastructure resilience, which according to Pursiainen [65] is the approach in the Nordic countries which focus “on vital societal functions rather than mere sector-based infrastructures” in their approach to securing critical infrastructure from multiple threats.

Exposure and hazard should not be limited to direct geographical or physical exposure to local natural hazards. Finns and Finnish organizations can be exposed to natural hazards, disasters and climatic changes across the globe; therefore, a network view on exposure is necessary.

Finally, the flip-side of risk should not be forgotten: **Opportunity identification** might seem macabre when discussing disasters or climate change, but the benefits harvested in seizing opportunities can be used to improve disaster risk management at home and abroad.

Here it should be noted that this study is exploratory and issue-raising in nature. Our analysis is not detailed enough to give direct advice on policy development. Instead we are promoting a more flexible and effective approach to designing integrated DRR and CCA policies. This calls for more research, both academic and practice-oriented, as well. A more nuanced scientific global risk assessment, mapping and modelling of complex causal effects regarding disaster and climate change impacts would clarify the global risk landscape and improve assessments of the global costs of adaptation and postponed mitigation. On a national scale, applied research on the scale and determinants of different risks should be conducted with a broad perspective. Naturally, we are not the only or first ones to suggest this, but we consider that our example of Finland shows that work remains to be done.

5. Conclusions

DRR and CCA are global efforts that call for international co-operation and increased integration at all levels of governance. Global and international perspectives should not, however, blur the view of the differences between countries and regions. Finland as a Nordic welfare state with low natural hazard levels serves as an example of a certain type of extremity with regard to DRR and CCA. We argue that the most severe weather and climate risks for modern-day Finland may be indirect. Thus, the most cost-effective investments to improve preparedness are likely to be ones that affect the root causes of these indirect risks. On the opposite end of the spectrum, for a poor and natural hazard prone country, direct investments in DRR and CCA capabilities may be more efficient. However, good governance and functioning institutions are a prerequisite to any such improvements and in principle clear—if perhaps in practice very difficult—steps to improve the situation: e.g. poverty reduction, improving administration, developing agricultural practices and increasing awareness, exist. For a Nordic welfare state with powerful institutions, high institutional and societal trust, low levels of disasters despite challenging climate, and a high level of capital and living standards, the path forward is less clear. Regardless of whether the Nordic welfare state model or parts of it are transferable, the analysis shows that the role of governance, as stated by Alexander and Davis [2] and UNISDR [85] is crucial in reducing weather and climate related disaster risk.

The complex nature of disaster risks and climate change calls for

more research. Further analysis is required on the contribution of different welfare state regimes to successful DRR and CCA, and how the changing cultures and governance regimes that are witnessed in the Nordic countries at the moment contribute to changing weather and climate risk. The role of political systems and culture as enabling factors for successful DRR and CCA should also be further studied. Further analysing the relation of contingent needs and conditions in comparison to the general frameworks could yield tools for measuring DRR and CCA resource efficiency. Altogether a more nuanced research approach would support more effective DRR and CCA policies and improve our conceptual and factual understanding of global risks. In addition to increasing DRR and CCA integration, integrating both into other global policy processes, such as Sustainable Development Goals, would be beneficial in the long run. Research into these topics can support this effort.

References

[1] D. Alexander, Mainstreaming disaster risk management, in: L. Bosher (Ed.), Hazards and the Built Environment: Attaining Built-in Resilience, Taylor & Francis, Oxford, UK, 2008, pp. 20–36.

[2] D. Alexander, I. Davis, Disaster risk reduction: an alternative viewpoint, Int. J. Disaster Risk Reduct. 2 (2012) 1–5, http://dx.doi.org/10.1016/j.ijdrr.2012.10.002.

[3] T.M. Andersen, B. Holmström, S. Honkapohja, S. Korkman, H.T. Söderström, J. Vartiainen, The Nordic Model: Embracing Globalization and Sharing Risks. ETLA B232, The Research Institute of the Finnish Economy (ETLA), Helsinki, 2007 〈http://economics.mit.edu/files/5726 〉 (Accessed 8 December 2017).

[4] M.B. Anderson, Which costs more: prevention or recovery? in: A. Kreimer, M. Munasinghe (Eds.), Managing Natural Disasters and the Environment, World Bank (Environment Department), Washington DC, 1991, pp. 17–27.

[5] P. Baxter, S. Jack, Qualitative case study methodology: study design and implementation for novice researchers, Qual. Rep. 13 (2008) 544–559.

[6] G.R. Biesroek, R.J. Swart, T.R. Carter, C. Cowan, T. Henrichs, H. Mela, M.D. Morecroft, D. Rey, Europe adapts to climate change: comparing national adaptation strategies, Glob. Environ. Change 20 (2010) 440–450, http://dx.doi.org/10.1016/j.gloenvcha.2010.03.005.

[7] J. Birkmann, K. von Teichman, Integrating disaster risk reduction and climate change adaptation: key challenges—scales, knowledge, and norms, Sustain. Sci. 5 (2010) 171–184, http://dx.doi.org/10.1007/s11625-010-0108-y.

[8] N. Brooks, W.N. Adger, P.M. Kelly, The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation, Glob. Environ. Change 15 (2005) 151–163, http://dx.doi.org/10.1016/j.gloenvcha.2004.12.006.

[9] I. Burton, Climate change and the adaptation deficit, in: E.L.F. Schipper, I. Burton (Eds.), The Earthscan Reader on Adaptation to Climate Change, Earthscan, London, 2009.

[10] Centre for Research on the Epidemiology of Disasters - CRED, n.d. EM-DAT The International Disaster Database. URL 〈http://www.emdat.be/database〉 (Accessed 8 December 2017).

[11] City of Pori. Porin kaupunkitulva 12.8.2007 Loppuraportti (Pori Urban Flood 12.8. 2007). (In Finnish). URL 〈http://pori.fi/material/attachments/hallintokunnat/tekninenpalvelukeskus/ajankohtaistaliikenteesta/raportit/5vA4Hx8Kn/Kaupunkitulvaraportti-lopullinen-22102009.pdf〉 (Accessed 12 August 2017).

[12] Climate-ADAPT, European Climate Adaptation Platform. The economics of managing heavy rains and stormwater in Copenhagen – The Cloudburst Management Plan, 2016. URL 〈http://climate-adapt.eea.europa.eu/metadata/case-studies/the-economics-of-managing-heavy-rains-and-stormwater-in-copenhagen-2013-the-cloudburst-management-plan〉.

[13] COM (European Commission), Communication from the Commission to the European Parliament, the Council, the European economic and social committee and the committee of the regions - an EU strategy on adaptation to climate change, COM (2013) (2013) (216 final).

[14] Decision No 1313/2013/EU of the European Parliament and of the Council. The Union Civil Protection Mechanism (UCPM). URL 〈http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?Uri=CELEX:32013D1313&from=EN〉 (Accessed 8 December 2017).

[15] Directive 2007/60/EC of the European Parliament and of the Council. On the Assessment and Management of Flood Risks. URL 〈http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?Uri=CELEX:32007L0060&from=EN〉.

[16] EEA (European Environment Agency), Climate Change, Impacts and Vulnerability in Europe 2016 - An Indicator-based Report. EEA Report 1/2017, Publications Office of the European Union, Luxembourg, 2017〈https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016/at_download/file〉.

[17] K. Eisenack, S.C. Moser, E. Hoffmann, R.J.T. Klein, C. Oberlack, A. Pechan, M. Rotter, C.J.A.M. Termeer, Explaining and overcoming barriers to climate change adaptation, Nat. Clim. Change 4 (2014) 867–872, http://dx.doi.org/10.1038/nclimate2350.

[18] S.H. Eriksen, K. O'Brien, Vulnerability, poverty and the need for sustainable adaptation measures, Clim. Policy 7 (2007) 337–352, http://dx.doi.org/10.1080/14693062.2007.9685660.

[19] E. Esping-Andersen, Why We Need a New Welfare State, Oxford University Press, New York, 2002, http://dx.doi.org/10.1093/0199256438.001.0001.

[20] E. Esping-Andersen, The Three Worlds of Welfare Capitalism, Princeton University Press, Princeton, New Jersey, 1990.

[21] European Commission, Special Eurobarometer 409 – Climate Change, European Commission, Directorate-General for Climate Action (DG CLIMA), 2014, 〈http://ec.europa.eu/public_opinion/archives/ebs/ebs_409_en.pdf〉 (Accessed 23 February 2017).

[22] Eurostat, Gross Domestic Product at Market Prices, (2017) 〈http://ec.europa.eu/eurostat/web/products-datasets/-/tec00001&lang=en 〉 (Accessed 8 December 2017).

[23] S. Fankhauser, T.K.J. McDermott, Understanding the adaptation deficit: why are poor countries more vulnerable to climate events than rich countries? Glob. Environ. Change 27 (2014) 9–18, http://dx.doi.org/10.1016/j.gloenvcha.2014.04.014.

[24] Finnish Road Administration, Central Administration. The Effect of Climate Change on the Routine and Periodic Maintenance of Roads (In Finnish with English Abstract). Finnra report 8/2009. Helsinki. URL 〈http://alk.tiehallinto.fi/julkaisut/pdf2/3201122-v-ilmastonmuutoksen_vaikutus_kunnossapitoon.pdf〉.

[25] FMI (Finnish Meteorological Institute). Climate in Finland. Official FMI web site, 2017. 〈http://en.ilmatieteenlaitos.fi/climate〉 (Accessed 8 December 2017).

[26] FMI (Finnish Meteorological Institute). Suomen ilmastovyöhykkeet (In Finnish). Official FMI web site, 2017. 〈http://ilmatieteenlaitos.fi/suomen-ilmastovyohykkeet〉 (Accessed 23 November 2017).

[27] FMI (Finnish Meteorological Institute), LUOVA answers the authorities' need for information when a natural disaster occurs, FMI News (2016), 〈http://en.ilmatieteenlaitos.fi/news/286502165〉 (Accessed 8 December 2017).

[28] FMI (Finnish Meteorological Institute), Record winds in Finland (in Finnish), 2015. 〈http://ilmatieteenlaitos.fi/tuuliennatyksia〉 (Accessed 8 December 2017).

[29] D.A. Gioia, A renaissance self: prompting personal and professional revitalization, in: R.E. Stablein, P.J. Frost (Eds.), Renewing Research Practice, Stanford University Press, Stanford, CA, 2004, pp. 97–114.

[30] H. Gregow, T. Carter, F. Groundstroem, R. Haavisto, S. Haanpää, M. Halonen, A. Harjanne, M. Hildén, J. Jakkila, S. Juhola, A. Jurgilevich, A. Kokko, V. Kollanus, T. Lanki, S. Luhtala, I. Miettinen, A. Mäkelä, V. Nurmi, K. Oljemark, A. Parjanne, P. Peltonen-Sainio, A. Perrels, K. Pilli-Sihvola, A.-J. Punkka, T. Raivio, A. Räsänen, K. Säntti, H. Tuomenvirta, N. Veijalainen, O. Zacheus, Measures to promote the management of weather and climate related risks (in Finnish with English abstract-Keinot edistää sää- ja ilmastoriskien hallintaa), ubl. Gov. Anal. Assess. Res. (2016) Act. No. 47/2016 http://tietokayttoon.fi/julkaisu?pubid=15406.

[31] A. Harjanne, R. Haavisto, H. Tuomenvirta, S. Luhtala, A. Mäkelä, H. Gregow, M. Halonen, T. Raivio, M. Hildén, A. Parjanne, J. Jakkila, S. Juhola, A. Räsänen, S. Haanpää, A. Jurgilevich, P. Peltonen-Sainio, T. Lanki, I. Miettinen, O. Zacheus, V. Kollanus, Management of Weather and Climate Risks and the use of Related Information Sources in Finland (In Finnish with English Abstract). FMI Reports 2016:6, Finnish Meteorological Institute, Helsinki, 2016 〈https://helda.helsinki.fi/handle/10138/168693 〉 (Accessed 4 December 2017).

[32] A. Harjanne, E. Pagneux, L.F. Jørgensen, A. Perrels, P. van der Keur, F. Nadim, J.K. Rød, E. Raats, Resilience to Natural Hazards: An Overview of Institutional Arrangements and Practices in the Nordic Countries. NORDRESS WP6.1 Report, (2016) 〈http://nordress.hi.is/wp-content/uploads/2015/01/WP6-1-report-of-task1-country-review_formatted.pdf 〉 (Accessed 8 December 2017).

[33] M. Hildén, F. Groundstroem, T.R. Carter, M. Halonen, A. Perrels, H. Gregow, Crossborder Effects of Climate Change in Finland (In Finnish with English Abstract). Publications of the Government's Analysis, Assessment and Research Activities 46/2016, Prime Minister's Office, Helsinki, Finland, 2016.

[34] L. Huovinen, Ruotsin, Norjan ja Tanskan kriisivalmiusjärjestelyt ja niiden kehittyminen 2000-luvulla sekä Pohjoismaisten mallien vertailu, Turvallisuus- ja puolustusasiain komitea TPAK (now Turvallisuuskomitea The Security Committee) Ministry of Defence, Helsinki, Finland, 2009〈https://www.defmin.fi/files/1462/Huovinen_Leena_070909.pdf〉 (Accessed 3 October 2017).

[35] Institute of Seismology, Catalog of Earthquakes in Finland since 2000 (in Finnish with English Abstract), Institute of Seismology. Department of Geosciences and Geography, University of Helsinki, 2017, 〈http://www.helsinki.fi/geo/seismo/maanjaristykset/suomi.html〉 (Accessed 8 December 2017).

[36] IPCC, Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2014.

[37] IPCC, Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, in: C.B. Field, V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G-K. Plattner, S.K. Allen, M. Tignor, P.M. Midgley (Eds.), A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, and New York, NY, USA, 2012, p. 582 http://www.ipcc.ch/report/srex/.

[38] Å. Johannessen, T. Hahn, Social learning towards a more adaptive paradigm? Reducing flood risk in Kristianstad municipality, Sweden, Glob. Environ. Change 23 (2013) 372–381, http://dx.doi.org/10.1016/j.gloenvcha.2012.07.009.

[39] M.M. Johansson, H. Pellikka, K. Kahma, K. Ruosteenoja, Global sea level rise scenarios adapted to the Finnish coast, J. Mar. Syst. (2012), http://dx.doi.org/10.1016/j.jmarsys.2012.08.007.

[40] P. Jokinen, Vaarallisia sääilmiöitä Suomessa (Video in Finnish: Dangerous weather phenomena in Finland), 2013. 〈https://ilmasto-opas.fi/fi/ilmastonmuutos/videot-ja-visualisoinnit/-/artikkeli/6c47483b-d0c5-4702-912a-6ecb14104336/vaaralllisia-saailmioita-suomessa.html〉 (Accessed 23 November 2017).

[41] S. Juhola, Mainstreaming Climate Change Adaptation: The Case of Multi-Level

Governance in Finland, in: E.C.H. Keskitalo (Ed.), Developing Adaptation Policy and Practice in Europe: Multi-Level Governance of Climate Change, Springer, Netherlands, 2010, pp. 149–187, , http://dx.doi.org/10.1007/978-90-481-9325-7_4.
[42] S. Juhola, S. Haanpää, L. Peltonen, Regional challenges of climate change adaptation in Finland: examining the ability to adapt in the absence of national level steering, Local Environ. 17 (2012) 629–639, http://dx.doi.org/10.1080/13549839.2012.665860.
[43] K. Jylhä, J. Jokisalo, K. Ruosteenoja, K. Pilli-Sihvola, T. Kalamees, T. Seitola, H.M. Mäkelä, R. Hyvönen, M. Laapas, A. Drebs, Energy demand for the heating and cooling of residential houses in Finland in a changing climate, Energy Build. 99 (2015) 104–116, http://dx.doi.org/10.1016/j.enbuild.2015.04.001.
[44] T. Kekki, T. Mankkinen, Turvassa? Kansalaisturvallisuuden tila Suomessa. Publications of the Government's Analysis, Assessment and Research Activities 8/2016, Prime Minister's Office, Helsinki, Finland, 2016 〈http://www.spek.fi/loader.aspx?id=fb3cc0dc-2686-41b0-a046-21e9e6d4c913 〉.
[45] S. Kellomäki, H. Peltola, T. Nuutinen, K.T. Korhonen, H. Strandman, Sensitivity of Managed Boreal Forests in Finland to Climate Change, with Implications for Adaptive Management, Philos. Trans. R. Soc. B 363 (2008) 2339–2349, http://dx.doi.org/10.1098/rstb.2007.2204.
[46] R.J.T. Klein, S. Juhola, A framework for Nordic actor-oriented climate adaptation research, Environ. Sci. Policy 40 (2014) 101–115, http://dx.doi.org/10.1016/j.envsci.2014.01.011.
[47] M. Komu, K. Hellsten, Luottamus ihmisiin ja luottamus instituutioihin Euroopassa (In Finnish). Nettityöpapereita 12/2010. Kansaneläkelaitos - The Social Insurance Institution of Finland, 2010. 〈https://helda.helsinki.fi/bitstream/handle/10138/16514/Nettityopapereita12.pdf?sequence〉.
[48] V. Kyyrönen, Kokonaisturvallisuus EU:ssa - Suomalainen varautumisen malli Euroopan unionin strategiatöissä, Turvallisuuskomitea (The Security Committee), Helsinki, Finland, 2014.
[49] A. Langley, C. Abdallah, Templates and turns in qualitative studies of strategy and management, in: D.D. Bergh, D.J. Ketchen (Eds.), Building Methodological Bridges, Research Methodology in Strategy and Management, Emerald, Bingley, UK, 2011, pp. 201–235.
[50] H. Laurikainen, Kotitalouksien varautuminen Suomessa. SPEK tutkii 13, Finn. Natl. Rescue Assoc. Spek. (2016) (URL), 〈http://www.spek.fi/loader.aspx?id=776d58cd-6703-475a-8c91-987ebf9629bb〉.
[51] A. Mäkelä, I. Lehtonen, K. Ruosteenoja, K. Jylhä, H. Tuomenvirta, A. Drebs, Climate Change in the Capital Area of Finland (in Finnish with English Abstract). FMI Reports 2016:8, Finnish Meteorological Institute, Helsinki, 2016〈https://helda.helsinki.fi/bitstream/handle/10138/170155/PKS_ilmastonmuutos.pdf?sequence=1〉.
[52] S. Mikkonen, M. Laine, H.M. Mäkelä, H. Gregow, H. Tuomenvirta, M. Lahtinen, A. Laaksonen, Trends in the average temperature in Finland, 1847–2013, Stoch. Environ. Res. Risk Assess. 29 (2015) 1521–1529, http://dx.doi.org/10.1007/s00477-014-0992-2.
[53] Ministry of Agriculture and Forestry, Finland's National Climate Change Adaptation Plan 2022 - Government Resolution 20 November 2014. Publication 5b2014, 2014. 〈http://mmm.fi/documents/1410837/5120838/MMM-_193086-v1-Finland_s_National_climate_Change_Adaptation_Plan_2022.pdf/582041ee-3518-4a63-bf60-7133aed95a9c〉 (Accessed 4 December 2017).
[54] Ministry of Agriculture and Forestry, Finland's National Strategy for Adaptation to Climate Change. Publication 1a/2005. Ministry of Agriculture and Forestry of Finland, 2005. 〈http://www.mmm.fi/attachments/ymparisto/5kghLfz0d/MMMjulkaisu2005_1a.pdf〉 (Accessed 24 April 2012).
[55] Ministry of the Interior Finland, National Risk Assessment 2015. Ministry of the Interior Publication 4/2016, Ministry of the Interior, Helsinki, 2016 (URL) 〈http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/64973/National%20Risk%20Assessment%202015.pdf 〉.
[56] Notre Dame Global Adaptation Initiative: University of Notre Dame. Notre Dame Global Adaptation Index (ND-GAIN Index). URL 〈http://index.gain.org/〉 (Accessed 8 December 2017).
[57] K. O'Brien, S. Eriksen, L. Sygna, L.O. Næss, Questioning complacency: climate change impacts, vulnerability and adaptation in Norway, Ambio 35 (2006) 50–56, http://dx.doi.org/10.1579/0044-7447(2006)35[50:QCCCIV]2.0.CO;2.
[58] C. Okereke, B. Wittneben, F. Bowen, Climate change: challenging business, transforming politics, Bus. Soc. 48 (2009) 584–586, http://dx.doi.org/10.1177/0007650309345272.
[59] J. Palme, Pension Rights in Welfare Capitalism: The Development of Old-Age Pensions in 18 OECD Countries, 1930 to 1985, Swedish Institute for Social Research, Stockholm, 1990.
[60] P. Peltonen-Sainio, L. Jauhiainen, K. Hakala, H. Ojanen, Climate change and prolongation of growing season: changes in regional potential for field crop production in Finland, Agric. Food Sci. 18 (2009) 171–190.
[61] K. Pilli-Sihvola, R. Haavisto, V. Nurmi, K. Oljemark, H. Tuomenvirta, S. Juhola, F. Groundstroem, I. Miettinen, H. Gregow, Efficient Weather and Climate Risk Management in Finland (in Finnish with English Abstract). Publications of the Government's Analysis, Assessment and Research Activities 45/2016, Prime Minister's Office, Helsinki, Finland, 2016〈http://tietokayttoon.fi/julkaisu?pubid=15404〉.
[62] K. Pilli-Sihvola, V. Nurmi, A. Perrels, A. Harjanne, P. Bösch, F. Ciari, Innovations in weather services as a crucial building block for climate change adaptation in road transport, Eur. J. Transp. Infrastruct. Res. 16 (2016) 150–173 http://tlo.tbm.tudelft.nl/fileadmin/Faculteit/TBM/Onderzoek/EJTIR/Back_issues/16.1/2016_01a_04.pdf.
[63] K. Pilli-Sihvola, S. Väätäinen-Chimpuku, Defining climate change adaptation and disaster risk reduction policy integration: evidence and recommendations from Zambia, Int. J. Disaster Risk Reduct. (2016), http://dx.doi.org/10.1016/j.ijdrr.2016.07.010.
[64] P. Pirinen, H. Simola, J. Aalto, J.-P. Kaukoranta, R. Ruuhela, Climatological Statistics of Finland 1981–2010 (In Finnish with English Abstract). FMI Reports 2012:1, Finnish Meteorological Institute, Helsinki, 2012 〈http://hdl.handle.net/10138/35880 〉.
[65] C. Pursiainen, Critical infrastructure resilience: a Nordic model in the making? Int. J. Disaster Risk Reduct. (2017), http://dx.doi.org/10.1016/j.ijdrr.2017.08.006.
[66] T. Rantanen, T.C. McLaughlin, T. Toikko, Do Finnish young people support the Nordic welfare state? Int. J. Soc. Soc. Policy 35 (2015) 47–66, http://dx.doi.org/10.1108/IJSSP-04-2014-0031.
[67] A. Räsänen, A. Jurgilevich, S. Haanpää, M. Heikkinen, F. Groundstroem, S. Juhola, The need for non-climate services – empirical evidence from Finnish municipalities, Clim. Risk Manag. 16 (2017) 29–42, http://dx.doi.org/10.1016/j.crm.2017.03.004.
[68] T. Rauken, I. Kelman, River flood vulnerability in Norway through the pressure and release model, J. Flood Risk Manag. 3 (2010) 314–322, http://dx.doi.org/10.1111/j.1753-318X.2010.01080.x.
[69] D. Rodrik, Institutions for high-quality growth: what they are and how to acquire them, St. Comp. Int. Dev. 35 (2000) 3–31, http://dx.doi.org/10.1007/BF02699764.
[70] K. Ruosteenoja, J. Räisänen, K. Jylhä, H. Mäkelä, I. Lehtonen, H. Simola, A. Luomaranta, S. Weiher, Climate Change Estimates for Finland on the Basis of Global CMIP3 Climate Models (in Finnish with English abstract). FMI Reports 2013:4, Finnish Meteorological Institute, Helsinki, 2013 〈https://helda.helsinki.fi/bitstream/handle/10138/42362/2013nro4.pdf?sequence=1 〉.
[71] Sähkömarkkinalaki 588/2013. Sähkömarkkinalaki. 〈http://www.finlex.fi/fi/laki/alkup/2013/20130588〉.
[72] R. Salli, M. Lintusaari, H. Tiikkaja, M. Pöllänen, Keliolosuhteet ja henkilöautoliikenteen riskit. Tutkimusraportti 68. Tampereen teknillinen yliopisto, tiedonhallinnan ja logistiikan laitos. Liikenne ja kuljetusjärjestelmät., Tampere, 2008. (URL) 〈http://www.tut.fi/verne/wp-content/uploads/keliriskit.pdf〉.
[73] J. Samson, D. Berteaux, B.J. McGill, M.M. Humphries, Geographic disparities and moral hazards in the predicted impacts of climate change on human populations, Glob. Ecol. Biogeogr. 20 (2011) 532–544, http://dx.doi.org/10.1111/j.1466-8238.2010.00632.x.
[74] P. Schmidt-Thomé, Natural and Technological Hazards and Risks Affecting the Spatial Development of European Regions (Special Paper 42), Geological Survey of Finland, 2006.
[75] Security Committee. Security Strategy for Society. Government Resolution 16.12.2010, 2010. 〈http://www.yhteiskunnanturvallisuus.fi/en/materials〉.
[76] C.M. Shreve, I. Kelman, Does mitigation save? Reviewing cost-benefit analyses of disaster risk reduction, Int. J. Disaster Risk Reduct. 10 (2014) 213–235, http://dx.doi.org/10.1016/j.ijdrr.2014.08.004.
[77] W. Solecki, R. Leichenko, K. O'Brien, Climate change adaptation strategies and disaster risk reduction in cities: connections, contentions, and synergies, Curr. Opin. Environ. Sustain. 3 (2011) 135–141, http://dx.doi.org/10.1016/j.cosust.2011.03.001.
[78] Standard & Poor's Ratings services, Climate Change is a Global Mega-Trend For Sovereign Risk, 2014. 〈http://maalot.co.il/publications/GMR20140518110900.pdf〉 (Accessed 8 December 2017).
[79] Statistics Finland, Official Statistics of Finland (OSF): Preliminary Population Statistics [e-publication], 2017. 〈http://www.stat.fi/til/vamuu/2017/09/vamuu_2017_09_2017-10-24_tie_001_en.html〉 (Accessed 4 December 2017).
[80] Statistics Finland, National Accounts, 2017. 〈http://www.stat.fi/tup/suoluk/suoluk_kansantalous_en.html〉 (Accessed 4 December 2017).
[81] Statistics Finland, Koulutus (Education), 2017. 〈http://tilastokeskus.fi/tup/suoluk/suoluk_koulutus.html〉 (Accessed 4 December 2017).
[82] Statistics Finland, Väestö (Population structure), (2017) 〈http://tilastokeskus.fi/tup/suoluk/suoluk_vaesto.html 〉 (Accessed 4 December 2017).
[83] R.A. Stebbins, Exploratory Research in Social Sciences, Sage University Papers Series on Qualitative Research Methods 48, Sage, Thousand Oaks, CA, 2001.
[84] F. Thomalla, T. Downing, E. Spanger-Siegfried, H. Guoyi, J. Rockström, Reducing hazard vulnerability: towards a common approach between disaster risk reduction and climate adaptation, Disasters 30 (2006) 39–48, http://dx.doi.org/10.1111/j.1467-9523.2006.00305.x.
[85] UNDP (United Nations Development Programme), Human Development Reports - Data, (2016) 〈http://hdr.undp.org/en/data 〉 (Accessed 8 December 2017).
[86] UNISDR, (United Nations International Strategy for Disaster Reduction), Making Development Sustainable: The Future of Disaster Risk Management. Global Assessment Report on Disaster Risk Reduction, United Nations Office for Disaster Risk Reduction (UNISDR), Geneva, Switzerland, 2015 (Accessed 26 November 2017), 〈http://www.preventionweb.net/english/hyogo/gar/2015/en/gar-pdf/GAR2015_EN.pdf〉.
[87] UNISDR (United Nations International Strategy for Disaster Reduction), Sendai Framework for Disaster Risk Reduction 2015–2030, UNISDR, Geneva, 2015.
[88] UNISDR (United Nations International Strategy for Disaster Reduction), Hyogo framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters. Extract from the final report of the World Conference on Disaster Reduction (A/CONF.206/6). UNISDR, Geneva, Switzerland, 2005. (Accessed 25 July 2013).
[89] L. van Well, A. Harjanne, A. Perrels, P. van der Keur, E. Pagneux, H.J. Henriksen, Resilience to natural hazards: an analysis of territorial governance in the Nordic countries, Int. J. Disaster Risk Reduct. (2017).
[90] N. Veijalainen, J. Jakkila, T. Nurmi, B. Vehviläinen, M. Marttunen, J. Aaltonen, Suomen vesivarat ja ilmastonmuutos – vaikutukset ja muutoksiin sopeutuminen (Finland's water resources and climate change - impacts and adaptation), Water.-

Proj. loppuraportti (2012) (In Finnish) ⟨https://helda.helsinki.fi/handle/10138/38789 ⟩.
[91] A. Votsis, Space and Price in Adapting Cities: Exploring the Spatial Economic Role of Climate-Sensitive Ecological Risks and Amenities in Finnish Housing Markets (Doctoral dissertation), University of Helsinki, Helsinki, Finland, 2017 (article-based), ⟨https://helda.helsinki.fi/handle/10138/173459⟩.
[92] M. Voutilainen, Poverty, Inequality and the Finnish 1860s Famine. Jyväskylä Studies in Humanities, 287 University of Jyväskylä, Jyväskylä, Finland, 2016 ⟨https://jyx.jyu.fi/dspace/bitstream/handle/123456789/49598/978-951-39-6627-0_vaitos13052016.pdf?sequence=1 ⟩ (Accessed 3 October 2017).
[93] WEF, Global Risks Report 2013, eight ed., World Economic Forum, Geneva, Switzerland, 2013 (Insight report) ⟨http://www3.weforum.org/docs/WEF_GlobalRisks_Report_2013.pdf ⟩ (Accessed 17 November 2017).
[94] B. Wisner, P. Blaikie, T. Cannon, I. Davis, At Risk, Routledge, London, 2003.